# Sea Ice Model for Marginal Ice Zone

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Award Number: N00014-00-C-0194
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## LONG-TERM GOALS

The long-term goal of the work is to understand the formation and decay of the frazil and pancake ice in the marginal ice zone.

## OBJECTIVES

The objective of the work is for Northwest Research Associates, Inc. (NWRA) in collaboration with the Technical University of Denmark (DTU) to develop a frazil/pancake model suitable for use by the National Ice Center (NIC) in the marginal ice zone. The ice analyst/forecasters at NIC currently use many kinds of data to analyze and forecast of ice conditions near the ice edge in regions of interest. The model (to be used as a tool) developed in this project will aid in ice analysis and forecasting. This project has been stopped and therefore NIC will not get the new tool.

## APPROACH

General model operations are outlined in Figure 1. At a certain time step (t=1), the model imports the current Special Sensor Microwave Imager (SSM/I) derived ice conditions as well as the mean atmospheric wind and temperature for the last 24-hour period (t=1corresponds to 24 hours.). The ice conditions from time step t=0 are then advected as prescribed by the 24 hour average wind, and a first guess of the ice conditions at t=1 are obtained by aging the ice one day. At every grid point the advected ice field parameters are compared to the observed (SSM/I) ice field at t=1. New ice is grown or some ice is melted to match the new SSM/I observations. The comparison of model output and data is made at ice concentration level, not the brightness temperature. This comparison is making use of available knowledge of the 'visibility' of various young/thin ice types as contained in the model, to the SSM/I sensor.

The overall plan is to deliver to NIC a model based on the model as described above. Improved versions of the model will be delivered to NIC each year of the 3 year contract. During the second year, the staff at NIC will use the new model in marginal ice regions of interest to them. The model tool will be used to attempt a "best fit" to historical ice forecast. This "best fit" would be obtained by varying air stress, water stress, and some parameters in the ice growth equations. It is expected that different variants of these parameters would be required for a "best fit" in different geographic locations. In essence, the model will be tuned to best produce the historical analysis for a series of locations.

# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **30 SEP 2003** | | **00-00-2003 to 00-00-2003** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **Sea Ice Model for Marginal Ice Zone** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Northwest Research Associates, Inc.,,14508 N.E. 20th Street,,Bellevue,,WA,98007** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

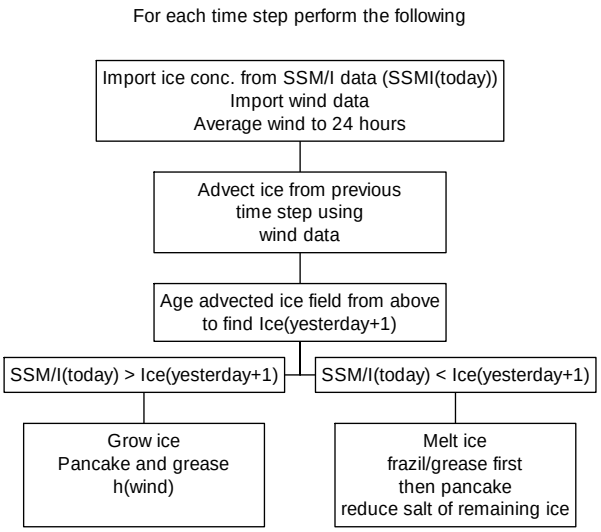
| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT **unclassified** | b. ABSTRACT **unclassified** | c. THIS PAGE **unclassified** | **Same as Report (SAR)** | **4** | |

## A marginal ice zone model for the US National Ice Center

**The ice**

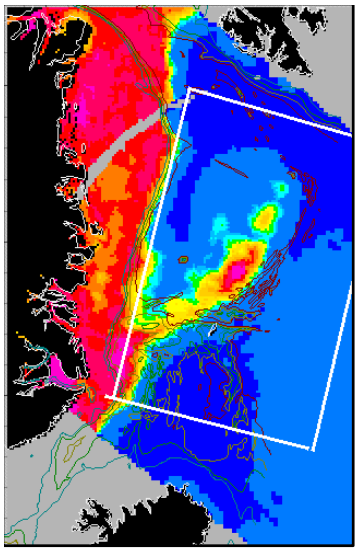
**Photos of frazil and pancake ice, 1997**

**The model**




**Model forced by daily SSM/I ice observations and daily winds**

**The Data**



**Example of daily SSM/I ice concentrations**

The model (to be used as a tool) will be based on the present model, will be of direct use to NIC, and will enhance the PIPS3.0 development. For the new tool, the inputs from PIPS are:

- Ice velocities.
- Ocean currents at the mixed layer.
- Temperature at the bottom of the ice.
- Air temperature (also might use local remeasured air temperatures).
- SSM/I as enhanced by forwarding using the model ice concentration levels.
- Air stress.

This data is required only for the local region of interest. Therefore, the data files are not very large. Point calculations of drift can be made and ice concentration can be determined from SSM/I.

## WORK COMPLETED

The first version of the model was delivered to NIC in February 2001 and it covers the Greenland, Weddell, and Bering Seas. The model is being tuned for the regions at NIC. At the February 2001 meeting the Statement of Work was revised and the schedule for the last two years of the project was set. Max Coon and Leif Toudal visited the NIC in August 2001 to work out the details of how to run the model for the Berents Sea and provide real time results to the Healy in support of the October cruise to the Barents, which was done. Leif Toudal visited the NIC in February 2002 to deliver the new version of the model. Leif Toudal, Matt Pruis, and Max Coon visited NIC in 2003 and the third version of the model can now run on the NIC data streams.

Publications: Toudal, L. and Coon, M.D., Interannual variability of the sea ice induced salt flux in the Greenland Sea, Accepted by Annales of Glaciology, 2000.

Presentations: Toudal, L. and Coon, M.D., Interannual variability of the sea ice induced salt flux in the Greenland Sea, IGS symposium on Sea Ice, Fairbanks, Alaska, June 2000.

Publication: Maksym, T., L. Toudal, M.D. Coon, M.L. Van Woert, "Operational Modeling of the Autumn Ice Advance in the Barents Sea," in press *IAHR*, 2003.

## RESULTS

- The third version of the model is currently being run on NIC data streams.
- A forecast module using the third version model has been developed.
- The model was used in support of the Healy Cruise in the Berents Sea in Fall 2002.
- The model has been run in Greenland, Berents, Bering, and Beaufort Seas, the Sea of Okhotsh, and the Weddell sea.
- Some tuning of the air stress and water stress have ben done.

## IMPACT/APPLICATIONS

This three-year project has been stopped. Therefore, the model (tool) being developed on this project to improve the ability of NIC to produce ice charts in the MIZ will not be completed.

## TRANSITIONS

This project would have transitioned the research being done in the related projects to a tool that was to be used by NIC to make ice charts.